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F01 Cruise Control Systems

Cruise Control Systems

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the new functions of DCC and ACC Stop and Go
- Locate DCC and ACC components

Introduction

Trusted Driver Assistance Systems

BMW has long since offered a comprehensive range of driver assistance systems. These make it easier for the driver to control the vehicle, by

- providing the driver with information,
- prompting the driver how to act or
- actively intervening in the way the vehicle is driven.

The systems presented have, for the most part, already been tried and tested in BMW vehicles for many years. These include:

- Cruise control with braking function
- Active Cruise Control with Stop & Go function
- Adaptive Brake Assistant with warning function.

The F01/F02 will see refinements and enhancements to improve customer benefits further still.

Standard and Optional Equipment

The following table is a comparison of standard equipment and options available for driver assistance systems. This comparison is between the E65 and F01:

System	E65		F01	
	Std.	Optional	Std.	Optional
Higher level Integrated Chassis Management			•	
Driver Assistance Systems				
Cruise control (FGR)	•			
Cruise control with braking function (Dynamic Cruise Control - DCC)			•	
Active Cruise Control		•		
Active Cruise Control with Stop and Go				•
Adaptive Brake Assistant with warning function				•
Active Blind Spot Detection (Lane Change Warning)				•

In the F01/F02, “Dynamic Cruise Control” (DCC) supersedes the cruise control (FGR) function available as standard in the E65.

The optional extra “Active Cruise Control with Stop & Go function” (ACC Stop & Go) provides optimum assistance to the driver not only in smoothly flowing traffic but also in traffic jam situations. Both systems are based on the new architecture of the Integrated Chassis Management (ICM).

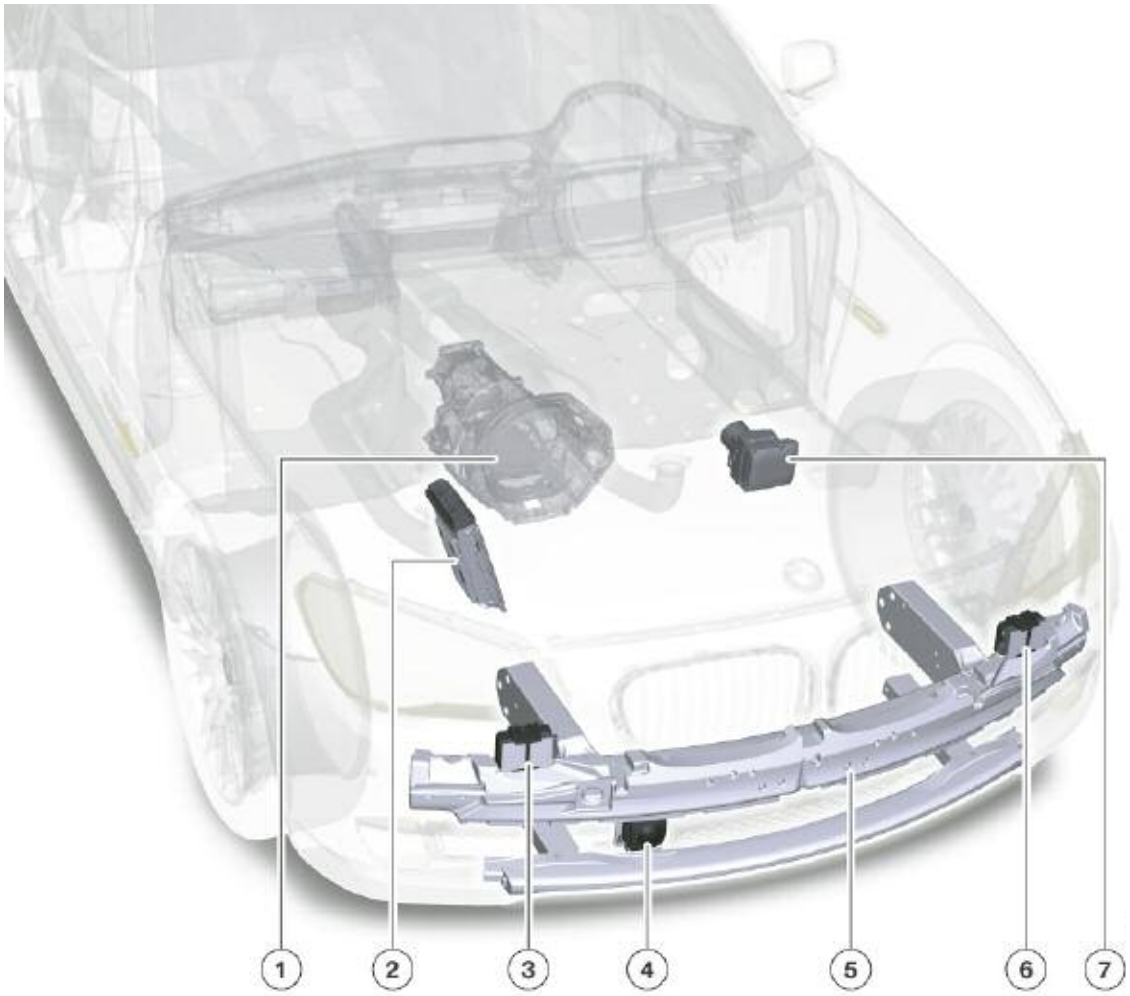
The primary aim of both items of optional equipment, ACC and ACC Stop & Go, is to relax the driver and, therefore, to make an improvement to the comfort/convenience area of the vehicle.

To assist the driver in panic braking situations as well, each of these items of optional equipment has been enhanced by the Adaptive Brake Assistant function. This safety function, which was first available in the E6x LCI, has been supplemented by a new warning function in the F01/F02. It alerts the driver to a risk of collision detected by the long-range radar sensor. This enables the driver to intervene even faster and, potentially, to avoid an accident.

System Overview

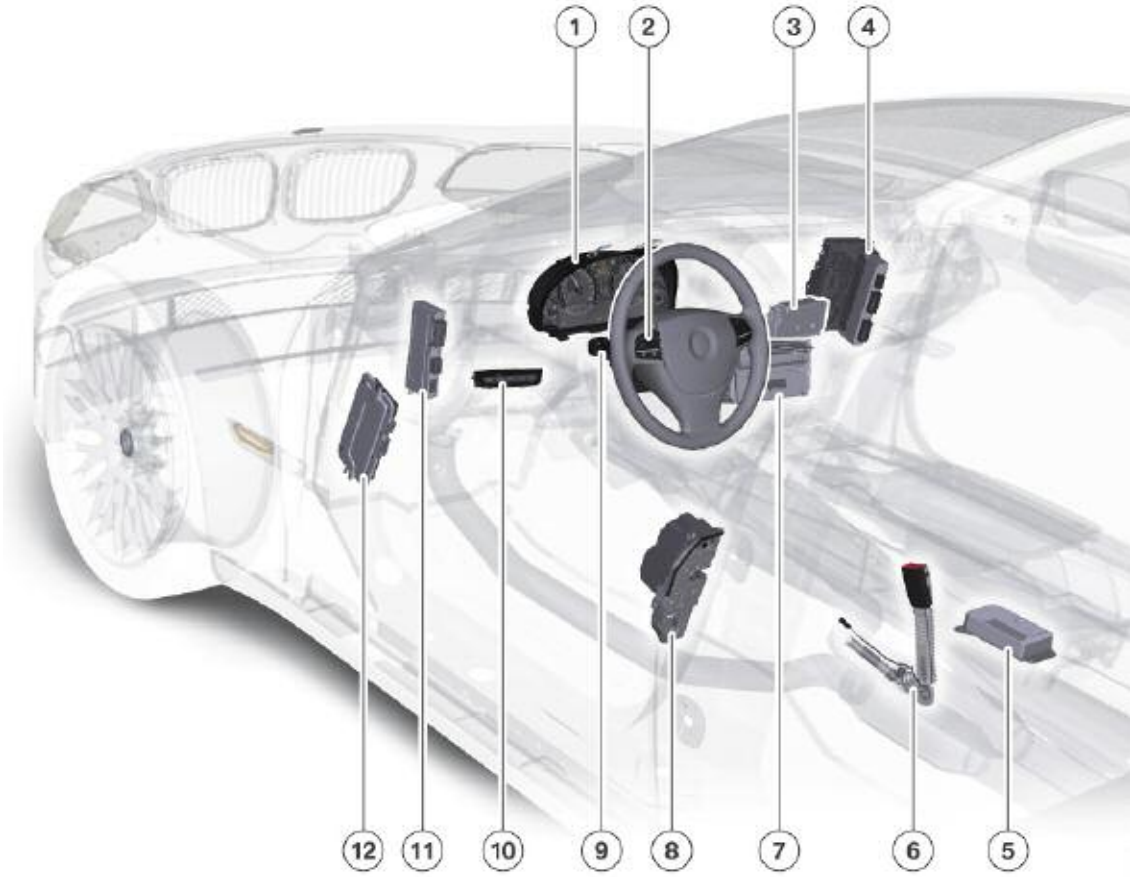
Components in the Vehicle

Components of DCC, ACC Stop & Go in the F01/F02 (view from front)



Index	Explanation
1	Electronic transmission control module
2	Engine control system
3	Short-range radar sensor (SRR), right
4	Long-range radar sensor (LRR)
5	Bumper cross-member
6	Short-range radar sensor (SRR), left
7	Dynamic Stability Control

Components of DCC, ACC Stop & Go in the F01/F02 (side view)



Index	Explanation
1	Instrument cluster
2	Multifunction steering wheel button pad
3	Crash safety module
4	Front fuse carrier, junction box electronics
5	Control unit for Integrated Chassis Management
6	Seat belt buckle contact, driver's seat
7	Car Information Computer
8	Door switch, driver's door
9	Steering column switch cluster with steering angle sensor
10	Driver assistance systems operating unit
11	Central gateway module
12	Footwell module

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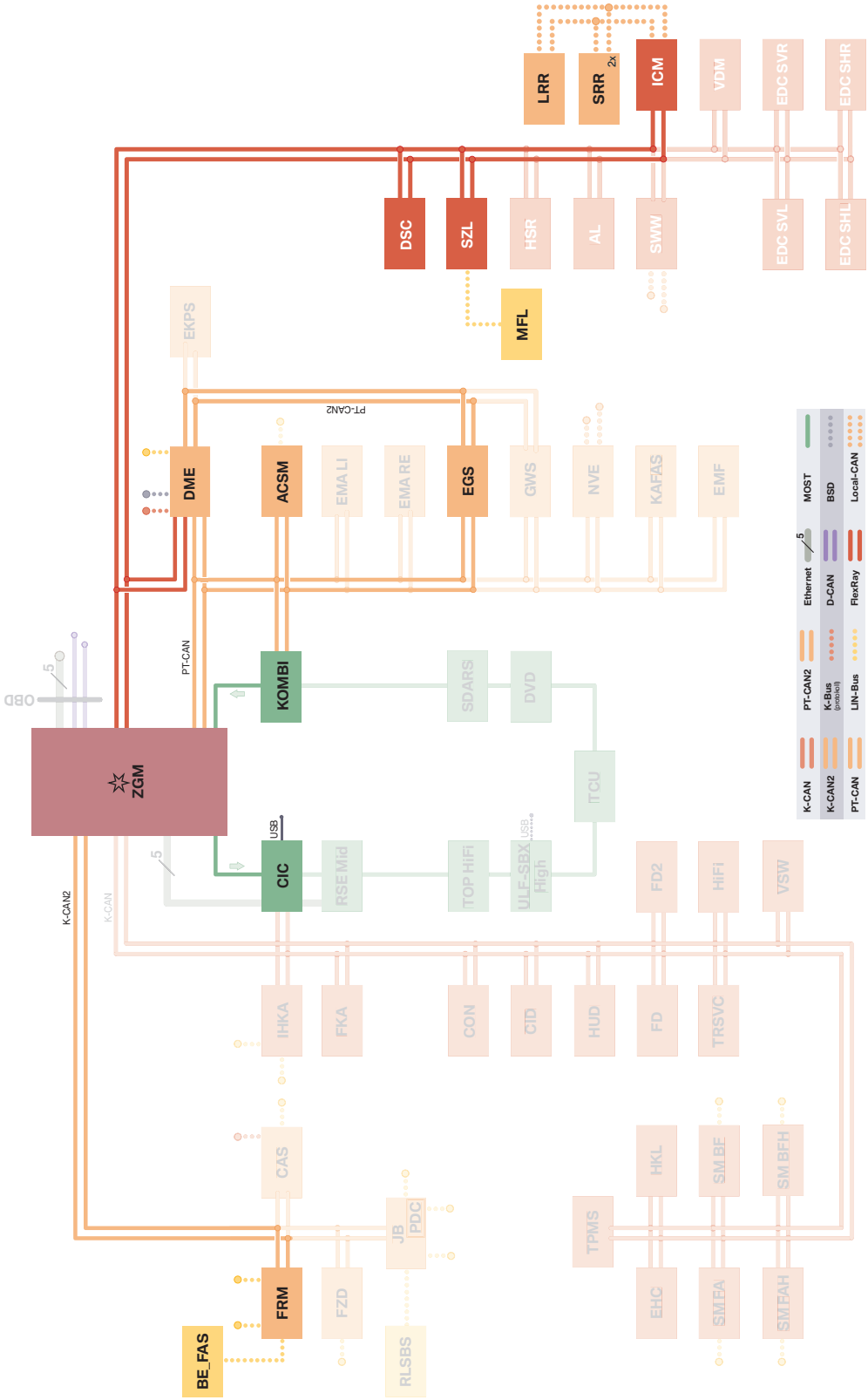
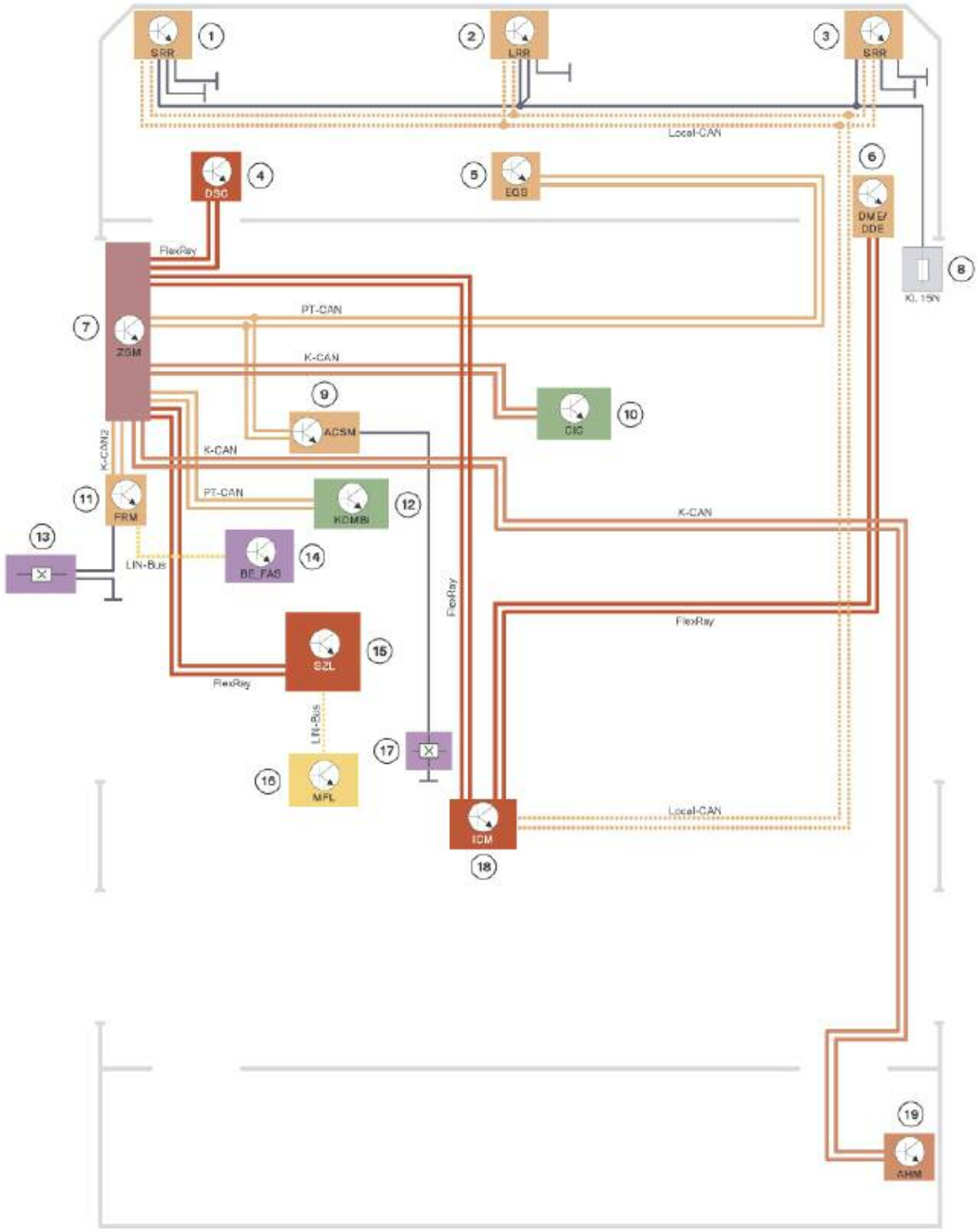
Bus System Overview



Index	Explanation
ACSM	Crash safety module
BE_FAS	Driver assistance systems operating unit
CIC	Car Information Computer
DME	Digital Motor Electronics
DSC	Dynamic Stability Control
EGS	Electronic transmission control unit
FRM	Footwell module
KOMBI	Instrument cluster
ICM	Integrated Chassis Management
JB	Junction box electronics
LRR	Long-range radar sensor (LRR)
MFL	Multifunction steering wheel button pad
SRR	Short-range radar sensor (SRR)
SZL	Steering column switch cluster with steering angle sensor
ZGM	Central gateway module

System Circuit Diagram

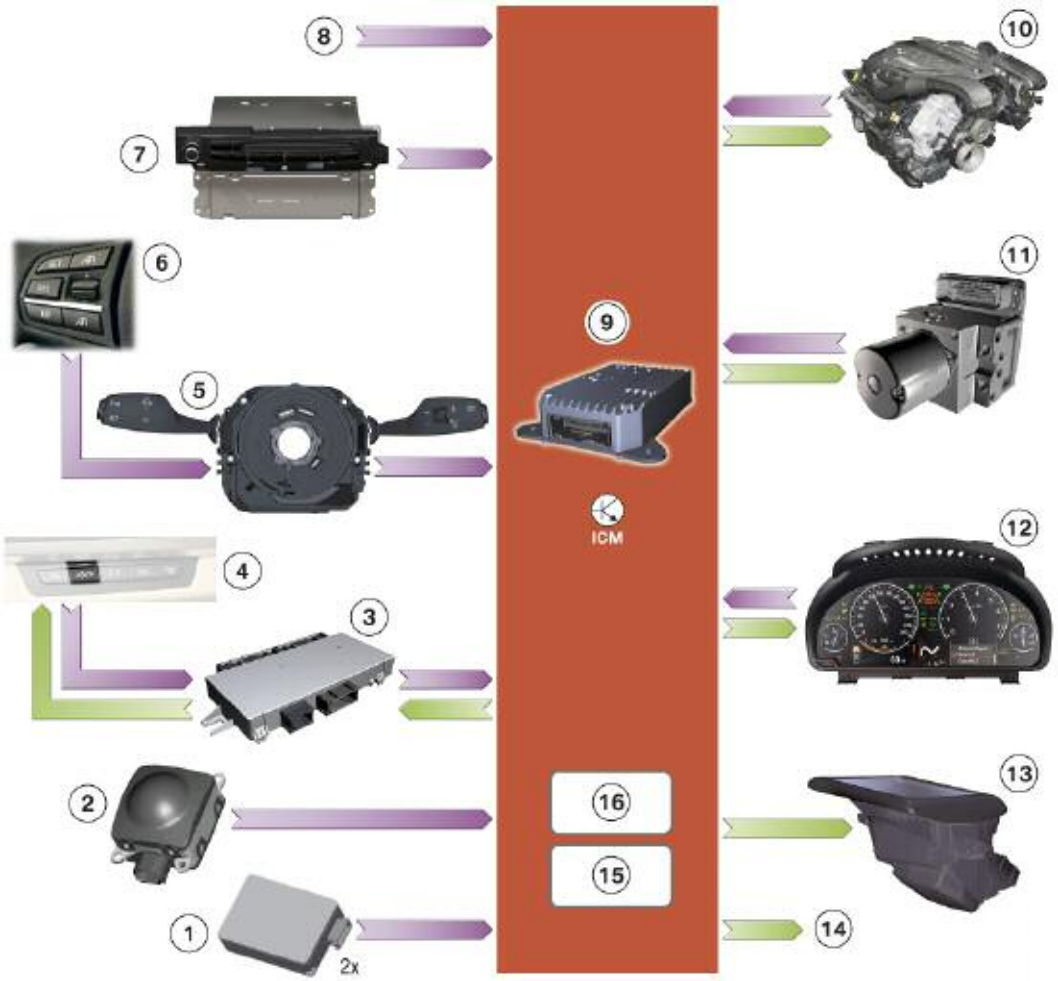


Index	Explanation
1	Short-range radar sensor, left
2	Long-range radar sensor
3	Short-range radar sensor, right
4	Dynamic Stability Control
5	Electronic transmission control unit
6	Digital Motor Electronics
7	Central gateway module
8	Fuse for long-range radar sensor and short-range radar sensors (front fuse carrier, junction box electronics)
9	Crash safety module
10	Car Information Computer
11	Footwell module
12	Instrument cluster
13	Door switch, driver's door
14	Driver assistance systems operating unit
15	Steering column switch cluster with steering angle sensor
16	Multifunction steering wheel button pad
17	Seat belt buckle contact, driver's seat
18	Integrated Chassis Management

Functions

Technical Networking Overview

ACC Stop & Go input/output diagram

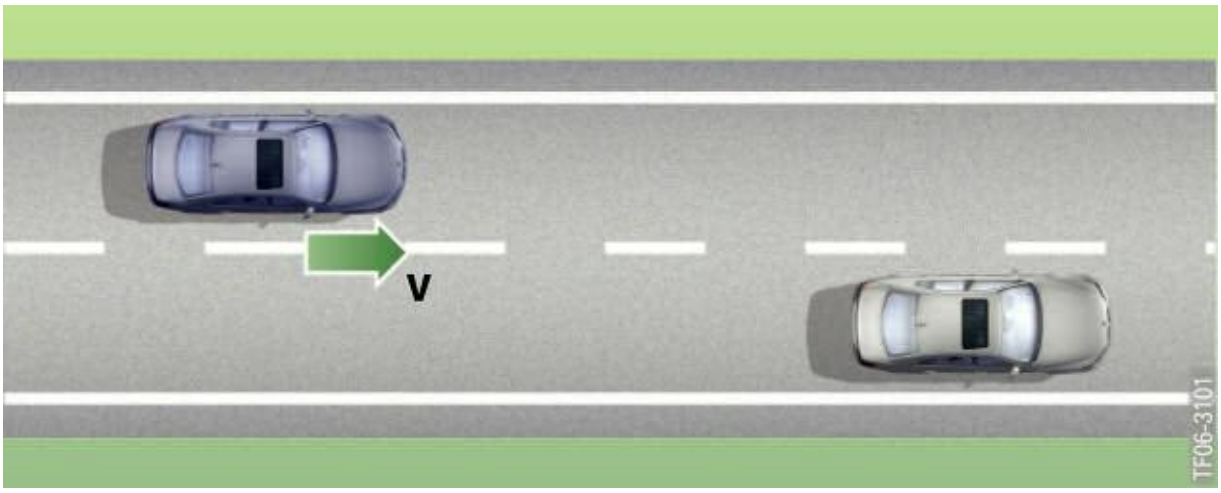


Index	Explanation	Explanation
1	Short-range radar sensors	• Detecting near objects • Pre-processing object data • Transmitting a list of object data to the ICM control unit on the local CAN
2	Long-range radar sensor	• Detecting distant objects, pre-processing object data and transmitting a list of object data for ACC Stop & Go to the ICM control unit on the local CAN • Detecting distant objects, pre-processing object data, establishing trigger criteria for the functions of the Adaptive Brake Assistant and transmitting them to the ICM control unit on the local CAN

Index	Explanation	Explanation
3	Footwell module	• Forwarding button-stroke signals from the driver assistance systems operating unit to the ICM control unit • Forwarding the request of the ICM control unit to activate/ deactivate the function illumination to the driver assistance systems operating unit • Generating the door contact signal (for recognition of driver's intention to get out)
4	Driver assistance systems operating unit	• Evaluating button strokes and transmitting the result to the footwell module • Activating/deactivating the function illumination at the request of the footwell module
5	Steering column switch cluster	• Forwarding the operating signals from the MFL button pad to the ICM control unit (for DCC/ACC Stop & Go) • Generating a number of other signals (e.g. steering wheel angle, turn signal operation)
6	MFL button pad	• Generation of driver control signals (for DCC/ACC Stop & Go)
7	Car Information Computer	• Generating the GPS position (deactivation of the short-range radar sensors of ACC Stop & Go in the vicinity of radio astronomy stations) • Generating road type and course of road segments to permit adaptation of controller parameters by ACC Stop & Go • Setting selected by the driver for collision warning of the Adaptive Brake Assistant
8	Other input signals	• Terminal status, engine running (from CAS) • Drive position of the automatic transmission (from EGS) • State of driver's seat belt buckle contact (from ACSM) • State of all actuators (e.g. drive, DSC, EMF, Kombi) necessary to the operation of DCC/ACC Stop & Go
9	Integrated Chassis Management (ICM)	• Analysis of objects and selection of relevant object (for ACC Stop & Go) • Interpretation of operating signals and generation of display signals (for DCC/ACC Stop & Go) • Regulation of straight-line speed and cornering speed (for DCC/ ACC Stop & Go) • Distance regulation (for ACC Stop & Go) • Control of drive train and brake actuators by outputting nominal values to the FlexRay (for ACC Stop & Go) • Gateway between local CAN and FlexRay (for diagnostics and programming of the long-range radar sensor) • Gateway between local CAN and FlexRay (for the functions of the Adaptive Brake Assistant)

Index	Explanation	Explanation
10	Drive train, comprising engine and transmission (DME and EGS)	• Implementation of the nominal values of the ICM control unit (for DCC/ACC Stop & Go) • Generation of signals from drive forces (for DCC/ACC Stop & Go)
11	Dynamic Stability Control (DSC)	• Implementation of the nominal values of the ICM control unit (for DCC/ACC Stop & Go) • Monitoring of stationary vehicle with ACC Stop & Go active • Implementation of the functions of the Adaptive Brake Assistant at the request of the ICM control unit (precharging of the brake system and reduction in the threshold of the hydraulic Brake Assistant) • Supply of signals relating to motion status of the car and brake pressure
12	Instrument cluster	• Implementation of the displays requested by the ICM control unit (for DCC/ACC Stop & Go and for the collision warning of the Adaptive Brake Assistant) • Generation of the signal for displayed speed (for DCC/ACC Stop & Go)
13	Head-up display	• Implementation of the displays requested by the ICM control unit (for DCC/ACC Stop & Go and for the collision warning of the Adaptive Brake Assistant)
14	Other output signals	• Calling up the Assistant window for setting the collision warning time (on CIC)
15	Control functions	• The control functions for both DCC and ACC Stop & Go are integrated into the ICM control unit
16	Status control	• ICM controls the status of DCC and ACC Stop & Go in accordance with received operating signals (and other signals). The status is needed outside the ICM control unit specifically for display information in the instrument cluster and in the head-up display • The activation and deactivation of the collision warning is also controlled by the ICM.

Cruise Control with Braking Function



Cruise control

The cruise control with braking function has already featured in the BMW 3 Series (E9x). It is also referred to as “Dynamic Cruise Control” (DCC).

It relieves the burden on the driver on quiet roads by maintaining a constant speed regardless of the resistance to vehicle motion (gradient, payload).

It also offers the driver the opportunity to adjust the set speed in small or large increments, which is then set and maintained by the system by controlling power output and braking. The brakes are also controlled during steep downhill driving if sufficient deceleration is not achieved by engine drag-torque alone.

Dynamic Cruise Control in the F01/F02 is not computed in the DSC control unit as it is in other vehicles. Instead, it has been integrated into the ICM control unit.

The function has, of course, been newly configured for optimum compatibility with the F01/F02. Due to the new vehicle interior, there are differences in how the function is operated and how information is displayed by comparison with the function implemented in other vehicles. These are described here.

Operation and display

In the F01/F02, Dynamic Cruise Control is no longer operated by means of an operating lever. Instead, the driver can operate the function conveniently using a button pad on the multifunction steering wheel.

Index	Explanation
1	SET button to activate
2	Rocker switch to change the set speed
3	I/0 button to switch on and off
4	RES button to resume a stored set speed

To prevent accidental activation, the function remains inoperable until the I/0 button has been pressed after the vehicle has started. This switches the function to standby. This state is acknowledged in the instrument cluster by a green indicator light lighting up.

With the function in standby, the driver is now able to activate cruise control. To do this, the driver can press the SET button used to store the vehicle's current road speed as the set speed. An active state is indicated by a green indicator light in the circumference of the speedometer dial lighting up.

There is an alternative way to activate the function if a set speed has already been stored. This is indicated by an orange indicator light in the circumference of the speedometer dial. If the driver wants to use this speed value as the set speed, he simply has to press the RES button. Dynamic Cruise Control then accelerates or decelerates the vehicle to this speed value automatically.

While the function is active, the driver is able to increase or decrease the set speed at any time. There are two adjustment increments available. The rocker switch offers two different increments in either direction. First, the set speed is altered in increments of 1 km/h each time the rocker switch is pressed; second, it is altered in increments of 10 km/h.

Note: In the F01/F02, the adjustment range for the set speed is 30 km/h (18 mph) to 230 km/h (142mph).

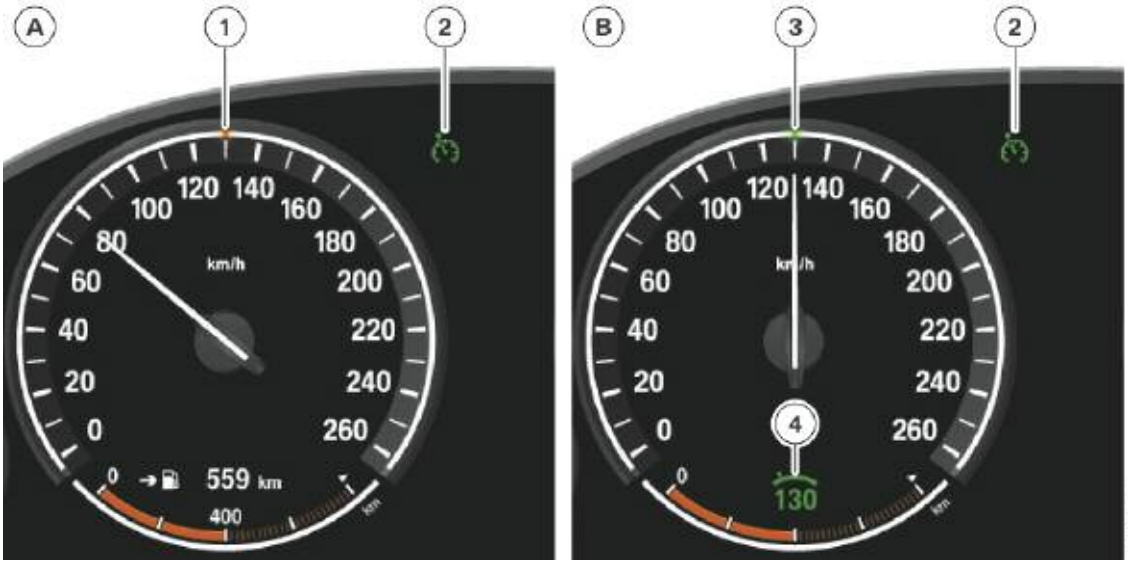
If the rocker switch is pressed and held, the system will accelerate/decelerate the vehicle until the rocker switch is released. This is known as a “comfort dynamics” function as featured in the E9x and E6x LCI.

To deactivate the system, the driver can simply operate the brake pedal like before.
Or, the driver can deactivate the system by pressing the I/0 button. The system is then returned to standby and keeps the set speed last used stored in its memory.

If the driver then presses the I/0 button once more, the system is completely switched off and the green indicator light in the instrument cluster goes out.

There follows a summary of the most important displays for Dynamic Cruise Control.

Dynamic Cruise Control displays in the F01/F02

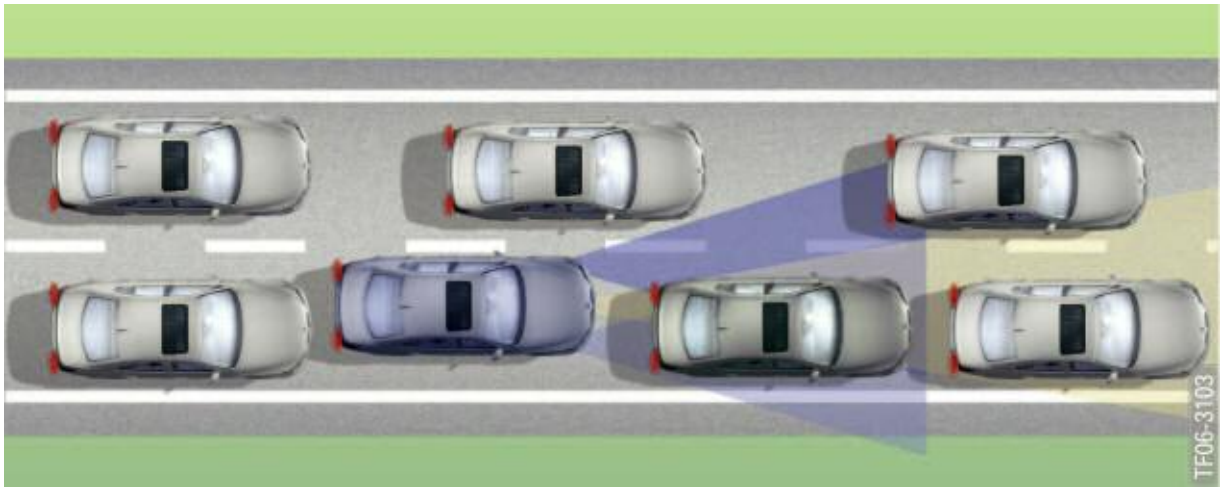


Index	Explanation
A	"Standby" state
B	"Active" state
1	Orange LED: set speed of 130 km/h (81 mph) stored
2	Indicator light for Dynamic Cruise Control
3	Green LED: actively maintaining a set speed of 130 km/h (81 mph)
4	Set speed displayed numerically: briefly displayed at the time of function activation or whenever the set speed is changed

In the event of particular operating states, the displays shown here are supplemented by information messages displayed below the speedometer. This is the case, for instance, if the driver attempts to activate the system even though not all the activation criteria have been fulfilled (e.g. speed less than 18 mph).

In the F01/F02, a difference in the way Dynamic Stability Control interacts with Dynamic Cruise Control has been introduced. This is explained by the following example: Using the “Dynamic Performance Control”, the driver has selected a mode in which DSC is inactive (e.g. “Sport+” mode). If the driver now activates cruise control, DSC will be activated automatically. This is accompanied by an automatic changeover from “Dynamic Performance Control” to “Normal” mode. In previous vehicles, the driver was unable to activate cruise control without activating DSC manually first.

Active Cruise Control with Stop & Go Function



Traffic jam situation

The ACC Stop & Go function in the F01/F02 is largely identical to that in the E6x LCI.

ACC Stop & Go extends the operating range of the former ACC system to include low speeds down to a standstill. In other words, speed and distance from the vehicle in front are automatically controlled at those speeds as well.

ACC Stop & Go will automatically stop the car if necessary and then indicate to the driver as soon as it detects that it is possible to start moving again. To pull away again, the driver has to acknowledge this message. The pulling-away process is controlled fully automatically by ACC Stop & Go only if the duration of the standstill is very short.

Thus, ACC Stop & Go provides optimum assistance for the driver not only in moving traffic but also in traffic jams such as are more and more frequently encountered on highways. However, this system (in common with ACC) is not intended for use in urban areas for negotiating junctions or traffic lights.

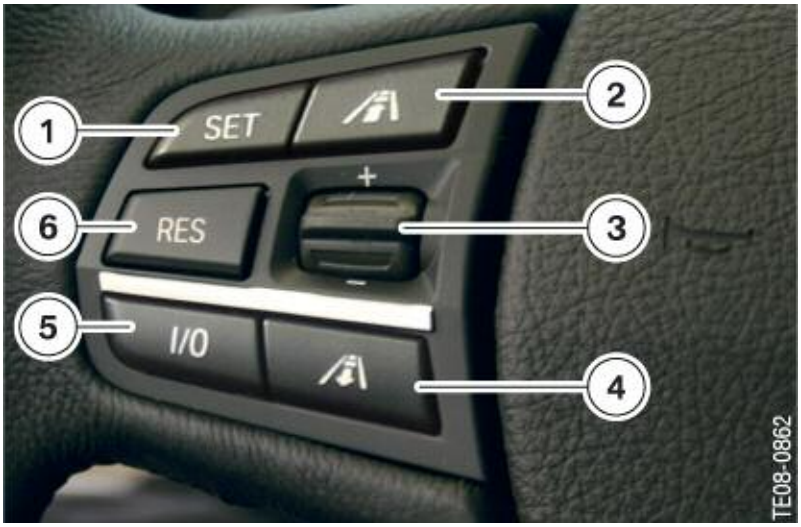
The functions of ACC Stop & Go in the F01/ F02 differ from those in the E6x LCI in the following areas:

- Operation and display
- Behavior in response to driver's intention to get out.

Operation and display

ACC Stop & Go and DCC are activated/ deactivated in a very similar way. The driver is able to activate ACC Stop & Go not only while the vehicle is in motion, but also when the vehicle is stationary, provided the system has detected another vehicle in front. To activate ACC Stop & Go at a standstill, the driver has to depress the brake pedal and press the SET or RES button at the same time. The activation conditions that applied to the E6x LCI similarly apply here:

- Brake pedal must not be depressed
- Automatic transmission must be in Drive
- Parking brake must not be activated
- Radar sensors must be operational and not dirty
- There must be no system fault present.



Index	Explanation
1	SET button to activate
2	Button for reducing the distance
3	Rocker switch to change the set speed
4	Button for increasing the distance
5	I/0 button to switch on and off
6	RES button to resume a stored set speed

If Dynamic Stability Control was inactive before, in the F01/F02 it is activated as soon as ACC Stop & Go is activated. At the same time, the “Dynamic Performance Control” automatically changes to “Normal” mode (same behavior as for DCC).

Similarly, ACC Stop & Go cannot be deactivated by means of the I/0 button while the vehicle is stationary unless the brake pedal is depressed at the same time.

Note: In the F01/F02, the adjustment range for the set speed is 30 km/h (18 mph) to 230 km/h (142mph).

By comparison with DCC, a vehicle with ACC Stop & Go has an MFL button pad that additionally features two buttons for making distance adjustments.

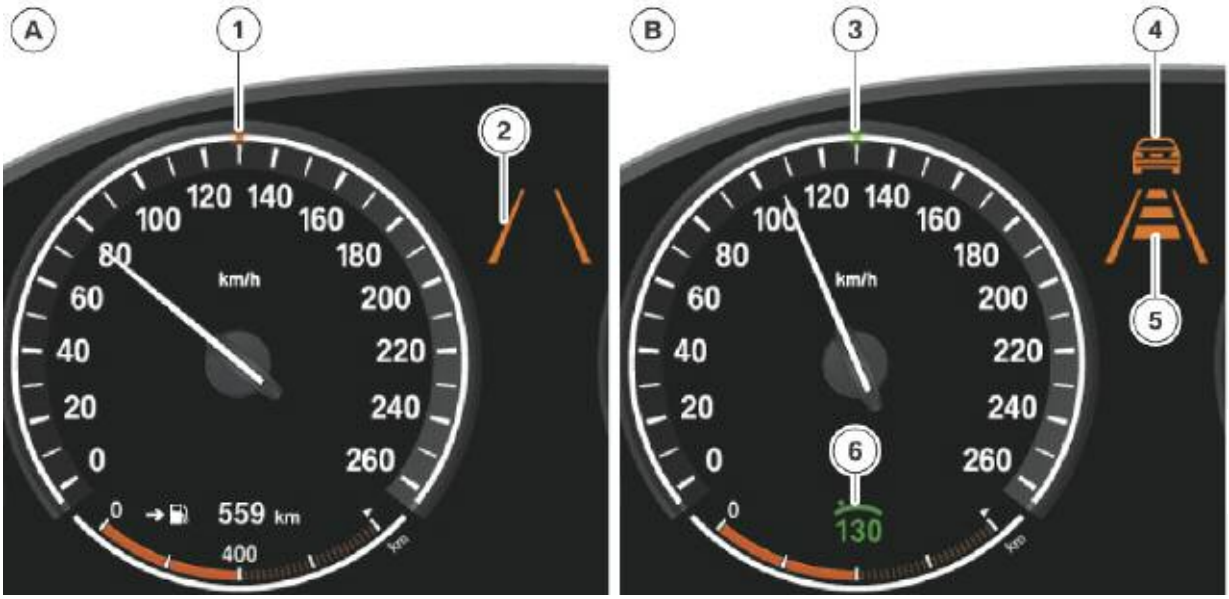
Each (short) button stroke to change the distance increases the desired distance used by ACC Stop & Go for its control process by one increment at a time. A total of four increments are available to the driver.

The most important display functions of ACC Stop & Go in the F01/F02 are illustrated below.

As with DCC, the display symbols for ACC Stop & Go are supplemented by messages displayed below the speedometer as and when necessary.

If the vehicle is equipped with the head-up display option, the ACC displays also appear there, provided the driver has configured them to do so.

ACC Stop & Go displays in the F01/F02



Index	Explanation
A	"Standby" state
B	"Active" state
1	Orange LED: set speed of 130 km/h (81 mph) stored
2	Lines that indicate "standby" mode
3	Green LED: set speed of 130 km/h (81 mph) selected by the driver (the speedometer needle is not pointing at the LED here because the vehicle in front is travelling slower than the set speed)
4	Car symbol: vehicle ahead detected by ACC Stop & Go
5	Bars: represent the distance increment selected by the driver
6	Set speed displayed numerically: briefly displayed at the time of function activation or whenever the set speed is changed

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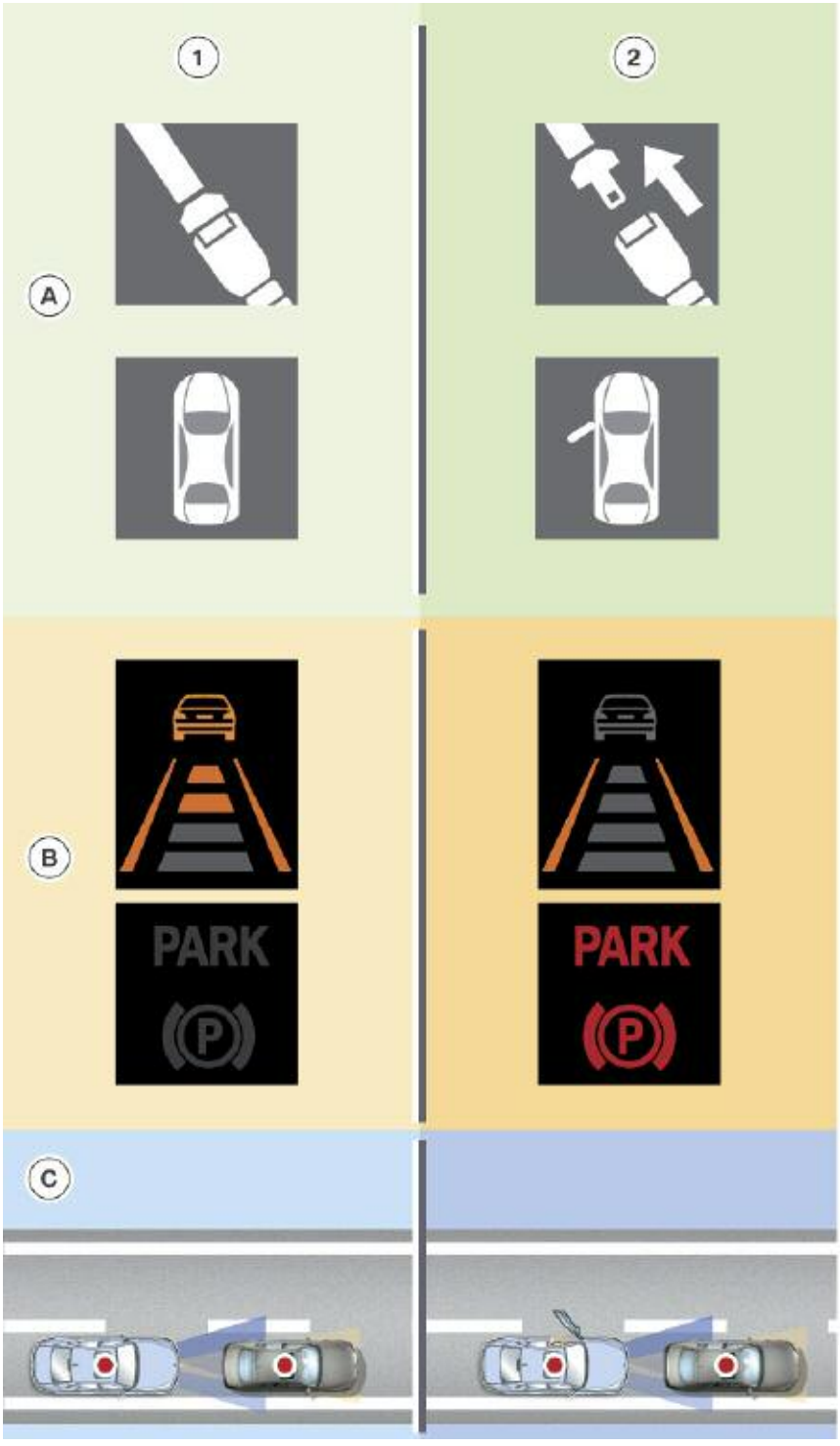
Behavior in response to the driver's intention to get out

ACC Stop & Go uses the DSC hydraulics to reliably slow the vehicle to a halt and keep it stationary.

Without a supply of electricity, the DSC hydraulics are, however, unable to indefinitely maintain the braking force necessary to keep the vehicle stationary.



Index	Explanation
A	State of driver's seat belt and driver's door
B	Displays of ACC Stop & Go and parking brake in the instrument cluster
C	Road traffic situation or perceptible response of vehicle with ACC Stop & Go
1	ACC Stop & Go is active and has automatically braked the vehicle to a halt behind a vehicle in front. The DSC hydraulics hold the vehicle stationary (and are monitored by the DSC control unit).
2	The driver has undone the seatbelt and opened the driver's door. This is evaluated as an unequivocal signal for the driver's intention to get out. DSC detects this state and activates the parking brake function. As a result, the vehicle can be held stationary for any length of time, even if the driver gets out. The parking brake indicator light indicates that the parking brake has been applied. ACC Stop & Go detects that the parking brake has been applied and switches off automatically.

By contrast with the E6x LCI, the F01/F02 is equipped with an electromechanical parking brake (EMF). This is able to assume the function of holding the vehicle stationary if

- DSC is no longer able to maintain the hold function due to a fault or overload,
- the driver gets out or
- the engine is switched off.

Thanks to the EMF, therefore, ACC Stop & Go also benefits from improvements designed to enhance comfort while the vehicle is stationary. Drivers of an E6x LCI had to be issued with a warning if they were about to get out with ACC Stop & Go still active. They were reminded to secure the vehicle against rolling away. They had to apply the parking brake manually.

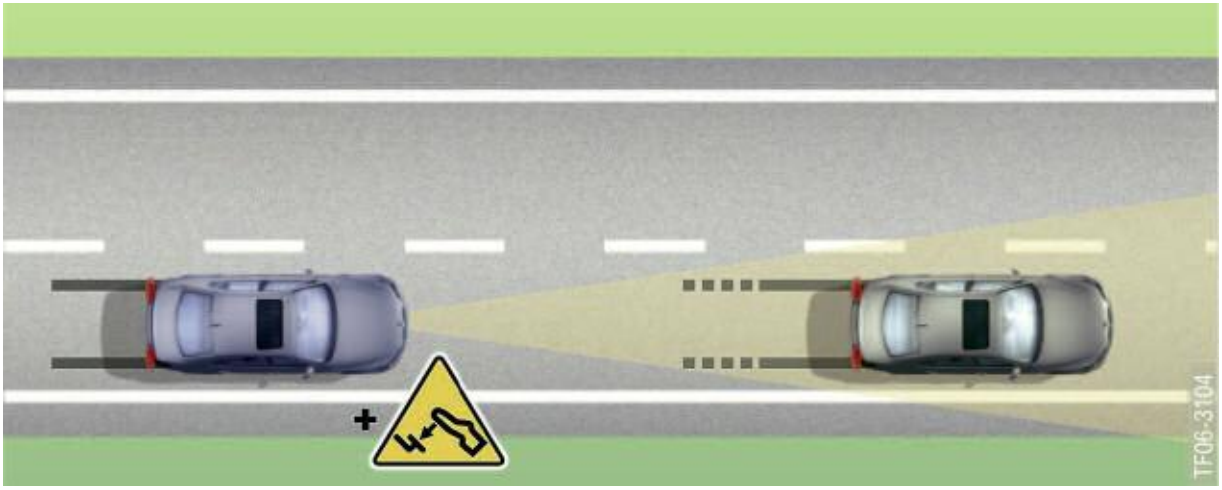
In the F01/F02, however, the parking brake function of the EMF is activated automatically whenever the driver is about to get out of the vehicle with ACC Stop & Go still active.

The driver’s intention to get out of the F01/ F02 is detected by the signals of the seat belt buckle contact (driver’s) and door contact (driver’s door). A signal from the seat occupancy detection (driver’s seat) is not used in the F01/F02.

While the vehicle is being held stationary by ACC Stop & Go, the DSC unit takes over all monitoring and control processes. The DSC also controls the system’s behavior in response to the driver’s intention to get out of the vehicle. For ACC Stop & Go, this is absolutely identical to that implemented for the DSC-internal Automatic Hold function (see the “F01/F02 longitudinal dynamics systems” Product Information).

ACC Stop & Go is deactivated automatically if, from the bus signals it receives, it detects that the parking brake function has been activated. Now the vehicle is still held stationary but by the parking brake function instead.

Adaptive Brake Assistant with Warning Function



Panic braking situation

As Featured in the E6x LCI

The Adaptive Brake Assistant has been carried over from the E6x LCI. This function is included automatically if the customer orders the ACC Stop & Go option, or in some countries, the ACC option.

Adaptive Braking Assistance offers the greatest benefit in situations where the vehicle is following another vehicle. If the vehicle in front brakes hard, it is detected by the long-range radar sensor. The two subfunctions of

- precharging the brake system (also known as the “brake readiness” function) and
- lowering the threshold for the hydraulic Brake Assistant

assist the driver to perform the braking operation to best effect and thus in the best case to avoid a rear-end collision with the vehicle in front.

In the F01/F02, this function is no different from the function implemented in the E6x LCI. The long-range radar sensor gathers data on the road users ahead of the vehicle. The data are supplemented by data relating to the driving status of the customer’s vehicle, and both types of data are used as a basis for calculating a collision avoidance rate of deceleration. This is the rate of deceleration at which the driver would have to brake in order to avoid a collision with the vehicle in front. If the calculated collision avoidance deceleration is above a stored threshold value, the brake system begins to precharge and the activation threshold for the hydraulic Brake Assistant is reduced.

All sensor-related and processing functions of Adaptive Braking Assistance are computed in the long-range radar sensor. However, the computed output variables have to be transmitted to the DSC control unit because that is where they are put into action. To make this possible, the ICM control unit acts as a gateway between the local CAN and the FlexRay.

In the DSC control unit, there are still more conditions that need to be fulfilled before these two subfunctions can be carried out. (Example: road speed must be higher than a defined minimum speed.)

However, the Adaptive Braking Assistance technology also has limits and cannot react fast enough in situations such as other road users cutting in right in front of the vehicle. Driving with care and anticipation remains the fundamental imperative even with Adaptive Braking Assistance!

Note: The Adaptive Brake Assistant and its subfunctions ,precharging the brake system and lowering the threshold for the hydraulic Brake Assistant are always active and does not have to be switched on separately by the driver.

New warning function

In the F01/F02, the Adaptive Brake Assistant is supplemented by a warning function. This useful “collision warning” is designed to draw the driver’s attention to hazardous situations in good time. The driver is then assisted by the subfunctions of the Adaptive Brake Assistant, which provide optimum deceleration in this kind of emergency situation.

The driver is able to switch the collision warning on and off. Its state (on/off) remains stored for the duration of the current driving cycle (key-specific).

The field of application in which the collision warning offers the greatest benefit to the customer is as follows: The customer is driving behind a vehicle that brakes suddenly and hard.

If the customer has activated the collision warning, he is given notification in two stages that a hazardous situation has been detected and the customer is thereby prompted to intervene:

- Advance warning
- Acute warning.

The time at which the warning has to be issued is, again, calculated by the long-range radar sensor based on the collision avoidance deceleration. Each warning stage has its own threshold values.

Setting the warning time

Setting the advance warning

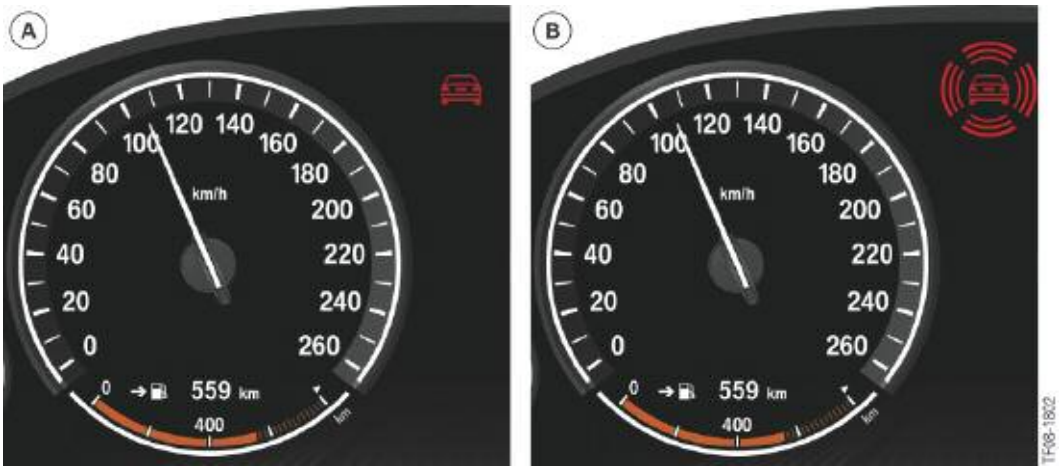
In the event of an advance warning, powerful braking by the driver is sufficient to allay the situation. If the acute warning is issued, the driver must brake immediately and with maximum force to avoid a collision.

The driver has some control over the threshold value for the activation of the first stage, the advance warning. From an Assistant window in the Central Information Display, the driver is able to select one of three warning times for the advance warning:

- Early
- Late
- Off (no advance warning given).

For the collision warning, the ICM control unit is responsible for the following control tasks. The switching on and off, the activation conditions, the fault monitoring and the adjustment of the warning time are all computed by the ICM. In addition, the ICM control unit forwards the warning request from the long-range radar sensor to the instrument cluster and (if fitted) the head-up display, where the warning is issued.

Issuing of the warning



Collision warning in the instrument cluster

Index	Explanation	Index	Explanation
A	Stage 1: Advance warning	B	Stage 2: Acute warning

The advance warning is represented by the red car symbol in the instrument cluster. In the event of an advance warning, it lights up constantly. As there is no audible signal, this visual warning signal is the only signal for the advance warning.

In the event of an acute warning, the car symbol in the instrument cluster begins to flash. Since an immediate intervention by the driver is required, this visual signal is supplemented by an audible tone.

Collision warning in the head-up display

Index	Explanation	Index	Explanation
A	Stage 1: Advance warning	B	Stage 2: Acute warning

This particular high-frequency tone is used only for the acute warning and differs distinctly from other tones that are issued, e.g. with Check Control messages.

If the vehicle is equipped with the head-up display, the visual displays of the collision warning are seen by the driver even more directly and therefore even sooner.

In the head-up display, the advance warning is represented by a significantly enlarged red car symbol. As with the instrument cluster display, the advance warning is indicated by the symbol lighting up constantly.

In the event of an acute warning, the car symbol in the head-up display begins to flash. At the same time, the parts of the display that are irrelevant to this emergency situation are hidden so as not to distract the driver unnecessarily. These displays include those of the navigation system, for example. As soon as the acute warning is over, all the displays in the head-up display re-appear. The same distinctive tone for the acute warning is used in vehicles with head-up display.

Note: The collision warning is active only if the driver has switched it on at the driver assistance systems operating unit.

As the advance warning is the first warning stage, its timing is configurable but it can also be switched off.

Fault states

The functions of the Adaptive Brake Assistant depend on the faultless operation of the long-range radar sensor in particular, but also of the ICM control unit and the DSC unit. If one of these essential system components is limited in its availability in any way, these functions may no longer work correctly and would need to be deactivated.

The driver is given notification of this condition. If, for example, a fault is present at the time the system is switched on, the function illumination of the collision warning will not be activated. From this, the driver can infer that the collision warning is not available.

If a fault were to occur some time after the system was switched on, the driver could fail to see the function illumination go out. For this reason, a Check Control message is issued as an additional warning measure. There are two different symbols, and each one is supplemented by a relevant instruction.

	
Collision warning deactivated (due to unfavorable operating conditions, e.g. dirty long-range radar sensor)	Collision warning failure (due to genuine faults or defective components)

System Components

Vehicle-specific Modifications in Detail

Long-range Radar Sensor

In terms of physical design, the long-range radar sensor (LRR) for ACC Stop & Go in the F01/F02 is largely identical to the one fitted in the E6x LCI.

Functionally, however, it differs from the sensor in the E6x LCI in that it also calculates the new collision warning of the Adaptive Brake Assistant.

In the F01/F02, the long-range radar sensor no longer has a connection to the wake-up line. Instead, it is supplied with power by terminal 15N and is thus hard switched. Terminal 15N is tapped off at the front fuse carrier. The long-range radar sensor contains a terminating resistor (for the local CAN) as it does in the E6x LCI.

The installation location of the long-range radar sensor and the way it is mounted have been adapted to the structural conditions specific to the F01/F02.

Installation location of the long-range radar sensor in the F01/F02

Index	Explanation	Index	Explanation
1	Fixed bearing	4	Housing/radome
2	Connector	5	Screw for vertical adjustment
3	Screw for horizontal adjustment	6	Bracket

Note: In the F01/F02, the long-range radar sensor is fitted with the connector at the top. It should therefore be noted that the adjustment screws have had to be relocated.

Note: Adjusting the long-range radar sensor on vehicles with Integral Active Steering: Before the adjustment device is set up and the actual adjustment work can begin, it is necessary to bring the actuator for the rear-wheel steering to the straight-ahead position. It is essential that the instructions of the diagnostic system and Repair Instructions be observed.

Short-range radar sensors

The short-range radar sensors (SRR) used for ACC Stop & Go in the E6x LCI have undergone a hardware revision. New, integrated switch circuits have been implemented. The principle of operation, however, is much the same. The table below compares the sensors' properties with those of the Lane Change Warning.

Characteristic	Radar sensors for Lane Change Warning	Short-range radar sensors for ACC Stop & Go
Modulation method	LF MSK (Linear Frequency Modulation Shift Keying)	PD (pulse doubler)
Mid-range transmission frequency 24 GHz	24 GHz	24 GHz
Bandwidth	100 MHz	> 1 GHz
Distance measurement	Based on the propagation time of one chirp[1]	Based on pulse propagation time
Measurement of relative speed	Based on frequency shift (Doppler effect)	Based on phase difference (Doppler effect)
Angle measurement	Ratio of two phase values (two simultaneous measurements)	Ratio of two phase values (two successive measurements)
Transmission output (typical maximum value)	Approximately 40 mW (typical), Approximately 100 mW (maximum)	Approximately 0.08 mW (average), Approximately 100 mW (single pulse)
Range (dependent on type of measured object)	At least 50 m, up to 70 m	At least 10 m, up to 20 m
Horizontal angular width of beam	Approximately -70° to +80°	+/-40°
Vertical angular width of beam	Approximately +/-6.5°	Approximately 20°

[1] Characteristic signal segment with changing frequency

Note: As in the E6x LCI, the short-range radar sensors cannot be programmed. While they do have a self-diagnostics function, accessing the ICM control unit is the only means by which it is possible to read their fault code memory entries.

The short-range radar sensors on the left and right are identical, as they are in the E6x LCI. Each of the short-range radar sensors detects its respective installation position from the pin that is assigned to ground in the wiring harness.

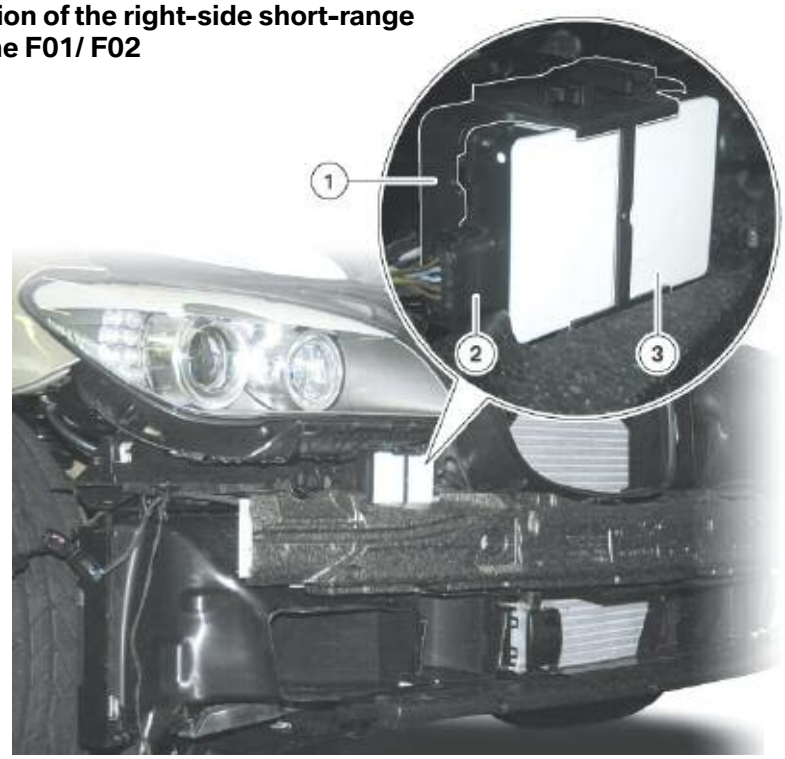
In the F01/F02, the short-range radar sensors -like the long-range radar sensor - are supplied with power by terminal 15N, which is supplied in turn by the front fuse carrier. There is no connection to the wake-up line.

The local CAN is connected to the short-range radar sensors by two short stub lines, which begin at the long-range radar sensor.

The short-range radar sensors have no terminating resistor for the local CAN.

The F01/F02 and the E6x LCI differ greatly in the installation location of the short-range radar sensors and in the way they are mounted. The key differences are illustrated here using as an example a short-range radar sensor fitted on the right-hand side when viewed in the direction of travel.

Installation location of the right-side short-range radar sensor in the F01/ F02



Index	Explanation	Index	Explanation
1	Bracket	3	Housing/antenna cover
2	Connector		

In the F01/F02, the short-range radar sensors are fitted on top of the bumper carrier (and no longer on its front). For this reason, the bracket had to be completely redesigned. It now grips the housing of the short-range radar sensor from behind. To guarantee the necessary level of stability and reliability, the bracket now also has a reinforcement rib. This runs vertically to the front of the antenna cover. The rib was positioned here in order to minimize its interference with the propagation of radar waves.

Note: The material for the bracket (and thus for the rib) was also selected specifically for this particular application. Emergency repairs that use other plastic parts are not permitted. Otherwise, there is a risk that the short-range radar sensors may not work correctly.

For the short-range radar sensors, a distinction is made between the following types of fault:

- **Sensors dirty:** The short-range radar sensors can no longer function reliably if their antenna is covered by snow, slush or ice. If this condition is detected, a corresponding signal is sent to the ICM control unit. The ACC Stop & Go function is deactivated as a result. A separate Check Control message informs the driver about this special case. There is no fault code memory entry.
- **External interference with radar signal processing:** Radar sensors used by other vehicle manufacturers may interfere with the signal evaluation of the short-range radar sensors. If such a problem is detected, the ACC Stop & Go is deactivated. It can be switched on again by the driver as soon as the vehicle is far enough away from the vehicle causing the interference. This malfunction is logged in the fault code memory of the ICM control unit. However, there is no repair action that can be taken. Instead, the customer should be informed of the cause of the fault (external interference).
- **Temporary fault:** The causes of this type of fault include communication faults, overvoltage, undervoltage and thermal overloads in the short-range radar sensors. In these cases, it is necessary to proceed as instructed by the test plan in the diagnostic system. The short-range radar sensors must not be replaced unless the test plan prompts you to do so.
- **Control unit fault:** If one of the short-range radar sensors is affected by a control unit fault, the only way to rectify the fault is to replace the defective sensor.
- **Sensors maladjusted:** As with the long-range radar sensor, the short-range radar sensors in interaction with the ICM control unit are also able to detect a maladjustment caused by an accident. If the calculated degree of maladjustment exceeds a certain limit, the ACC Stop & Go function is shut down. An entry in the fault memory indicates the cause of the fault. To correct the fault, observe the instructions in the diagnostic system and Repair Instructions.

In the F01/F02, too, as with the long-range radar sensor, there is no means of adjusting the short-range radar sensors.

Note: If a short-range radar sensor has been replaced with a new one, it is necessary to commission the sensor using the diagnostic system. While commissioning is in progress, new short-range radar sensors are taught their respective installation position and, importantly, their angle relative to the vehicle longitudinal axis. A measurement does not need to be carried out in this case. The angle entered is the angle predetermined by the construction and the form of the bumper support.

Note: Great care must taken during repair work carried out at the front end. If the bumper carrier is deformed or if the bumper trim is scratched or dented, the short-range radar sensors may no longer work correctly. The specified structural clearances between the short-range radar sensors and the bumper trim must also be maintained. The Repair Instructions must be observed without fail.

New Components

Integrated Chassis Management

The new ICM control unit in the F01/F02 essentially performs the calculations for the control functions that influence the longitudinal and lateral dynamics. The ICM control unit also contains the control functions of “Dynamic Cruise Control” and “Active Cruise Control with Stop & Go function”.

In addition, the ICM coordinates the control of the vibration actuator in the steering wheel for the “Lane Departure Warning” and “Lane Change Warning” driver assistance functions. Also integrated into the ICM control unit are micromechanical sensors that supply the driving dynamics signals (in previous vehicles, these were generated by the separate DSC sensor).

Two versions

An ICM control unit is installed in every F01/ F02. Which of the two available versions of the ICM control unit is fitted depends on the vehicle’s equipment level.

If the vehicle is equipped with one or both of the following options

- Integral Active Steering (IAL) or
- Active Cruise Control with Stop & Go function (ACC Stop & Go),

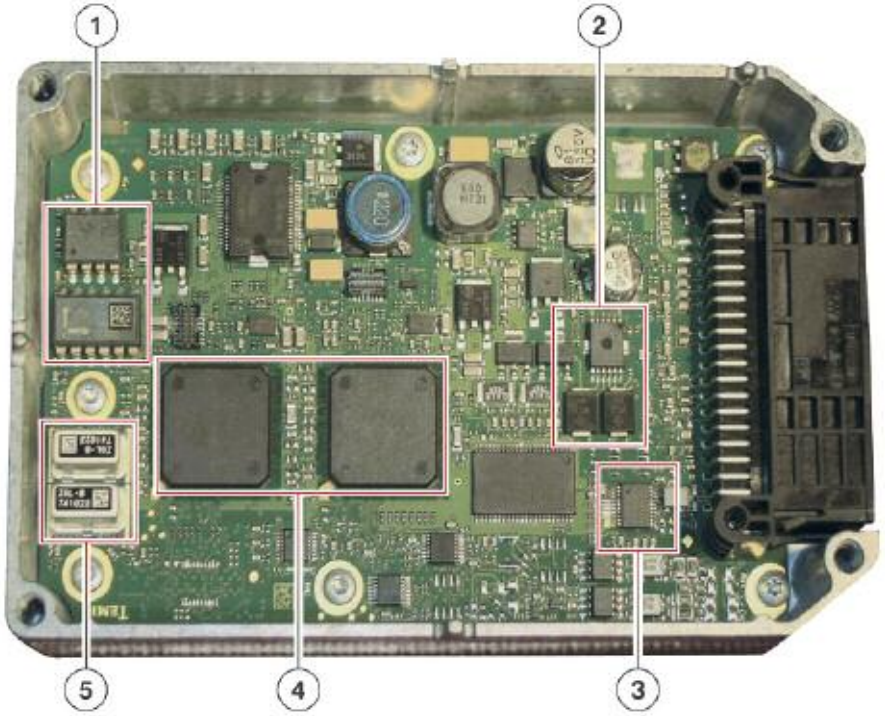
the high-performance version of the ICM control unit is installed.

If neither of these options are installed in the vehicle, the basic version of the ICM control unit is used.

The internal layout of the high-end version differs from the internal layout of the basic version in the following ways:

- Larger microprocessor (required to calculate the Integral Active Steering control and active speed control)
- Redundant sensor system for lateral acceleration and yaw rate (safety requirement for Integral Active Steering).

ICM control unit, high-end version



Index	Explanation
1	Acceleration sensors (1 for longitudinal acceleration, 2 for lateral acceleration)
2	Output stages for Servotronic and EVV valves
3	Controller for FlexRay connection
4	Two microprocessors (high-performance version)
5	Yaw rate sensors (2x)

Electrical interfaces

The control unit has a 54-pin plug via which the power supply, sensors, actuators and bus systems are connected.

As is the case with the controller housing, the plug does not have a watertight design. This is not necessary as it is installed on the inside of the vehicle.

The ICM control unit is connected to the integrated FlexRay controller via the **FlexRay** bus system. A detailed description of the new features of the FlexRay network is provided in the Product Information for the F01/F02 bus systems. The communication with most partner control units is handled by the microprocessors in the ICM via the FlexRay.

The FlexRay is routed to the ICM control unit (from the central gateway module) and continues from there (to the DME). The ICM control unit is related to the FlexRay, i.e. not an end node. This is why it does not have a terminating resistor for the FlexRay.

A further bus system, a **local CAN**, is connected to the ICM control unit in addition to the FlexRay. Its sole purpose is to enable the ICM to communicate with the long-range radar sensor and the short-range radar sensors. This local CAN therefore performs the same tasks as the sensor CAN in the E6x LCI that connects the LDM control unit to the sensors. It transmits information on road users that has been recorded by the sensors.

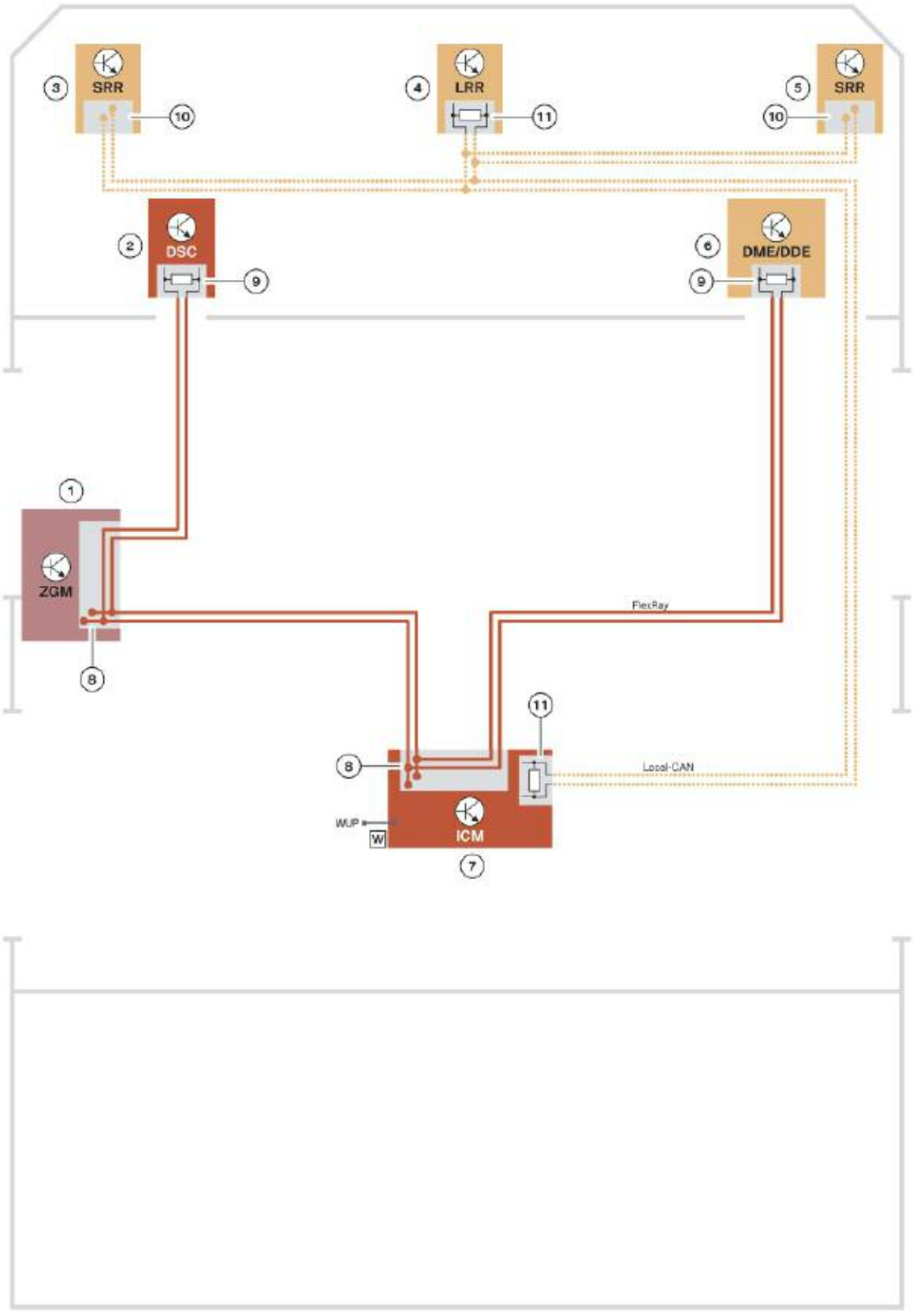
The local CAN operates in the same way as the PT-CAN with a data transfer rate of 500 kBit/s. There are two terminating resistors for the local CAN, each with 120 .. One of these is in the ICM control unit, the second terminating resistor is integrated in the long-range radar sensor. The local CAN is routed to the short-range radar sensors by short stub lines.

The pins for the local CAN are only connected at the plug of the ICM control unit if it is a high-end version.

The ICM control unit is also connected to the **wake-up line**. The ICM control unit can be woken up via the wake-up line.

Power is supplied from the front fuse carrier by terminal 30B.

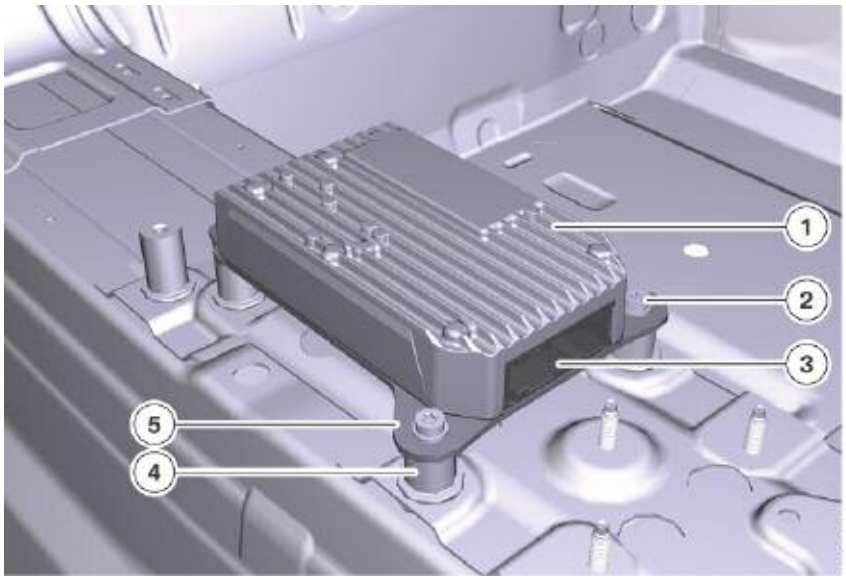
Electrical interfaces of the ICM control unit



Index	Explanation	Index	Explanation
1	Central gateway module	8	FlexRay routing and continuation without terminating resistor
2	Dynamic Stability Control	9	Routing of FlexRay with terminating resistor
3	Short-range radar (SRR) sensor, left	10	Routing of local CAN without terminating resistor
4	Long-range radar sensor (LRR)	11	Routing of local CAN with terminating resistor
5	Short-range radar sensor (SRR), right	W	ICM control unit can be woken up
6	DME control unit	WUP	Wake-up line
7	ICM control unit		

Installation location

The ICM control unit is installed in the center console behind the sensor for the crash safety module. This means that the position of the control unit and its integrated sensor system in the vehicle -near to its center of gravity -is ideal from the point of view of driving dynamics. The mounting points on the body are precisely determined and are measured when the vehicle is manufactured and must not be replaced with any other mounting points.



Index	Explanation	Index	Explanation
1	Upper section of housing	4	Spacer sleeve
2	Mounting bolt	5	Lower section of housing
3	Connector		

The housing of the control unit is connected to the metal body of the transmission tunnel with four screws and spacer sleeves made of aluminum. The control unit must be mounted on the vehicle body free of play as otherwise vibrations may be induced in the control unit housing which would severely impair the operation of the integrated sensor system. A secondary task of this mounting is to conduct heat away from the control unit to the body.

For the mounting to be able to perform these tasks, the following points must be observed when mounting and replacing the ICM control unit:

Note: Only screws and spacer sleeves that are in perfect condition may be used. Deformed or damaged fixing elements must not be used.

The mounting screws in the reamed holes must be tightened first, followed by the other two screws. The tightening torque specified in the repair instructions must be observed without fail.

A check must then be carried out to make sure the control unit is mounted securely and free of play.

To ensure sufficient heat dissipation and to avoid vibrations, the sides and top of the control unit housing must not come into contact with other vehicle components. Instead, the spaces provided around the control unit as part of the engineering design must always remain free of other components.

Removing and installing the ICM control unit

The ICM control unit performs tasks that are important for many vehicle functions, e.g. provision of sensor signals. If the vehicle were operated without the ICM control unit installed, a large number of vehicle functions would not be available. In the area of dynamic driving systems, for example, the Servotronic and stabilization functions would no longer be available. In addition, fault code memory entries would inevitably also be generated in many control units.

Note: If the ICM control unit needs to be replaced, the repair instructions must be observed without fail.

For example, the vehicle battery must be disconnected before removing the control unit and reconnected following the installation. This is the only way to ensure synchronized restarting of the control unit assembly.

Note: Once the new ICM control unit has been installed, it must be started up with the assistance of the diagnostic system. To do this, the following steps must be carried out (depending on the equipment specification):

- **Calibration of the sensors integrated into the ICM**
- **Calibration of the ride-height sensors**
- **Initialization of the Integral Active Steering.**

Commissioning the short-range radar sensors

In vehicles with the ACC Stop & Go option, the ICM control unit also plays an important role in the interaction with the short-range radar sensors.

Although short range radar sensors are intelligent sensors that perform the functions of a control unit they cannot be accessed directly via the diagnostic system. The ICM control unit acts as a “go-between” between the short range radar sensors and the diagnostic system which is why the ICM also controls the start-up process for the short range radar sensors.

Note: The short range radar sensors for ACC Stop & Go must be started up if one (or both) short range radar sensor(s) is/are replaced. In this instance, the diagnostic system communicates with the ICM control unit. The ICM in turn controls the corresponding functions in the short range radar sensors.

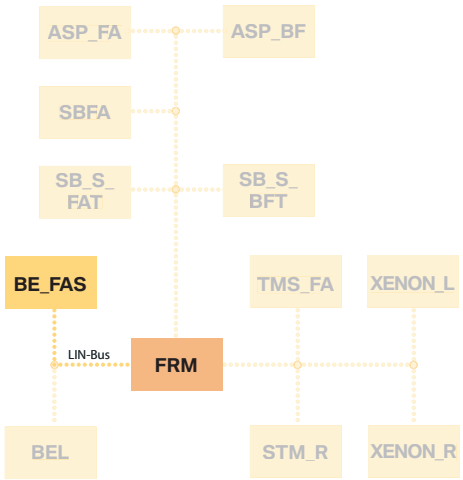
Display and Operating Controls

Driver assistance systems operating unit

Index	Explanation
1	Function illumination
2	Button for the warning function of the Adaptive Brake Assistant

The driver assistance systems operating unit contains a button for switching the collision warning on and off. The operating unit is connected to the footwell module (FRM) on the LIN bus. A bus signal from the FRM notifies the ICM control unit when the button has been pressed.

LIN bus subscribers at the footwell module



Index	Explanation
BE_FAS	Driver assistance systems operating unit
FRM	Footwell module

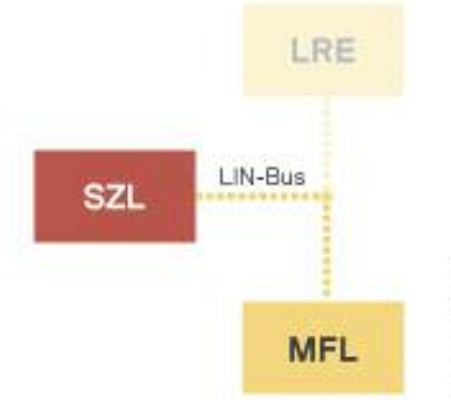
The ICM does not allow the collision warning to switch on unless the entire system is working faultlessly. It is only then that a bus signal providing positive feedback is sent to the FRM in order to have the function illumination in the button light up. If, however, a fault is present in any part of the entire system, the function illumination remains off even if the button is pressed. From this, the driver can infer that the collision warning is not available.

Multifunction steering wheel button pad

Which version of the MFL button pad on the left-hand spoke of the multifunction steering wheel is fitted depends on which option, DCC or ACC Stop & Go, is fitted in the vehicle. This does not apply to the MFL button pad on the right-hand spoke, which is the same regardless of whether the vehicle is equipped with DCC or ACC Stop & Go.

The operation and function of the buttons were described in the “functions” section.

LIN bus subscribers at the steering column switch cluster



Index	Explanation
MFL	Multifunction steering wheel
SZL	Steering column switch cluster

The electronics of the multifunction steering wheel evaluate the button strokes on both MFL button pads. On the LIN bus, the signals are transmitted to the steering column switch cluster (SZL). The SZL forwards the button stroke signals to the ICM control unit on the FlexRay. This is where the signals for controlling the DCC and ACC Stop & Go function are evaluated.

There is no function illumination on the MFL button pad. For this reason, no feedback is sent by the ICM control unit to the MFL button pad as it is to the driver assistance systems operating unit.